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(71) Applicant *(for all designated States except US)*: **OUTOKUMPU OYJ** [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **KOKKONEN, Kasper** [FI/FI]; Krakantie 8 A 5, FIN-01510 Vantaa (FI). **KOSKIMAA, Jarmo** [FI/FI]; Ohrakaskenmäki 15 A 2, FIN-02340 Espoo (FI). **JYRKÖNEN, Satu** [FI/FI]; Kaunokkitie 4, FIN-28450 Vanha-Ulvila (FI).

(74) Agent: **OUTOKUMPU OYJ, INTELLECTUAL PROPERTY MANAGEMENT**; P.O. Box 27, FIN-02201 Espoo (FI).

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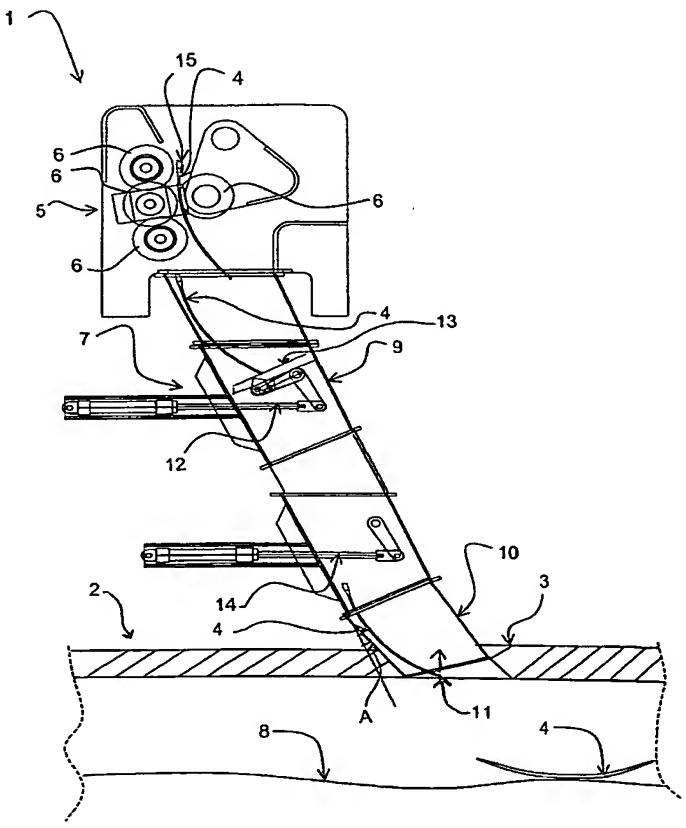
(54) Title: METHOD AND ARRANGEMENT FOR FEEDING AN ANODE INTO A SMELTING REACTOR



(57) Abstract: The invention relates to an arrangement for feeding an anode into a metallurgical smelting reactor (2), such as a flash converter, said arrangement including a feeding funnel (7) made of at least one part for feeding at least one anode (4) at a time into the smelting reactor, said arrangement also including a bending element (5) for bending the anode, so that the essentially completely bent anode (4) is arranged to meet the surface of the melt (8) contained in the smelting reactor in an essentially horizontal position. The invention also relates to a method for feeding an anode into a metallurgical smelting reactor (2).

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METHOD AND ARRANGEMENT FOR FEEDING AN ANODE INTO A SMELTING REACTOR

The invention relates to an arrangement and method defined in the preamble of the independent claims for feeding an anode into a metallurgical smelting reactor.

In the flash smelting of copper, the dried copper concentrate is fed into a furnace together with oxygen-enriched air and silica sand. The energy needed in the smelting process is created in the oxidation of sulfur and iron. Molten phases are separated from the gas in the settler as slag and matte are settled on the furnace bottom, so that the matte layer is placed lowest underneath. The primary task of slag is to gather in a fluent, dischargeable form the iron oxides created in the smelting process, as well as the silicatic and oxidic ingredients of the gangue. The matte obtained from a smelting furnace is further processed by converting. In converting, oxygen is blasted in the melt, and there is created blister copper, i.e. raw copper, with a copper content of the order 99 per cent. The copper remaining in the slag is recovered by flotation, and by feeding the high-copper slag concentrate back into the smelting furnace or by treating the slag in oxidizing conditions, for example in an electric furnace. After converting, blister copper still contains a certain amount of sulfur, wherefore it is further refined in an anode furnace. The purpose of the refining process is to decrease the sulfur content so low that copper anodes can be cast. After refining, copper is cast into copper anodes to be used in electrolysis, where copper cathodes are manufactured.

In electrolysis, copper anodes are dissolved along with the process, and copper is precipitated on the cathode surfaces. However, the whole anode cannot be utilized in electrolysis, but undissolved remnants, i.e. anode scrap, is left of the anodes. Generally anode scrap is fed back into the smelting reactor, in order to resmelt it and thus to utilize the copper contained therein.

However, as anode scrap contains a large amount of copper after the anode furnace treatment, it is not sensible, from an energy-economical point of view, to feed the anode scrap back into a flash smelting furnace or other corresponding first oxidizing metallurgic reactor of copper concentrate. It is known that anode

scrap is fed into a converter in order to advantageously recover the copper contained therein. However, when feeding sharp, sheet-like anodes into a converter, they have been noticed to cause damage to the reactor linings when anodes are dropped into the melt.

From the US patent 5,685,892, there is known an arrangement and method for feeding anode scrap into a metallurgical furnace used in copper smelting. According to said publication, anode scrap is fed into the furnace through a charging assembly, said assembly being provided with a device that prevents the anode from damaging the furnace bottom when it is dropped into the melt. As means for protecting the furnace bottom when anode scrap is fed in, the patent describes the bending of the anode ends and a turning mechanism that alters the dropping trajectory by means of a jump rail construction. The end of an anode is bent, and the anode is dropped into a dropping chute provided in connection with the charging assembly, so that the bent part of the anode is the lower end, when seen in the dropping direction, and the bent end points towards the ceiling of the charging chute. As the anode meets the melt surface, the area of the bent part slows down the immersion of the anode.

In the US patent US 5,497,978, there is described an apparatus for charging anode scrap into a converter. The patent depicts how anode scrap is fed by means of a charging mechanism, along a chute, into a converter. In addition, it is described how, by using adjustable shutters provided in connection with the chute, the space located inside the furnace is insulated from the air outside the furnace.

Among the drawbacks of the prior art solutions, there are the complexity of the arrangements and the steep dropping trajectory of the anodes into the melt.

The object of the present invention is to introduce a novel solution for feeding anode scrap into a smelting reactor. A particular object of the invention is to feed an anode into a smelting reactor as essentially completely bent and so that during the falling of the anode, its trajectory is altered, so that it meets the melt surface in an essentially horizontal position.

The invention is characterized by what is set forth in the preamble of the independent claims. Other preferred embodiments of the invention are characterized by what is set forth in the rest of the claims.

Many advantages are gained by the method and arrangement according to the invention for feeding an anode into a metallurgical smelting reactor, and drawbacks of the prior art are avoided by means of the invention. According to the invention, an arrangement for feeding an anode into a metallurgical smelting reactor, such as a flash converter, includes a feeding funnel made of at least one piece, for feeding at least one anode at a time into a smelting reactor, and the arrangement also includes a bending element for bending the anode, so that the essentially completely bent anode is arranged to meet the surface of the melt contained in the smelting reactor in an essentially horizontal position. By using the arrangement according to the invention, it is possible to feed anodes into the smelting reactor either in a batch or one by one. By bending the anode essentially completely, i.e. on both sides with respect to its center, it is possible to shift its center of gravity and thus to achieve an advantageous effect in its dropping behavior. According to a preferred embodiment, the feeding funnel is arranged in the immediate vicinity of the reaction shaft of the smelting reactor. By dropping the anodes in the vicinity of the reaction shaft, they are obtained in an optimal area with respect to the smelting process.

According to a preferred embodiment of the invention, the feeding funnel is made of two parts, a top part and a bottom part, so that the angle of inclination of the top part with respect to the horizontal level is larger than the angle of inclination of the bottom part. The placing of the bottom part at a different angle than the top part, the anode trajectory – as the anode is dropped – is altered advantageously so that the anode is made to turn into a horizontal position. According to a preferred embodiment, the angle between the top part and the bottom part of the feeding funnel is essentially 10 – 30 degrees. According to another preferred embodiment, the feeding funnel includes a trajectory-shifting element for altering the trajectory of the anode. The employed trajectory-shifting element can be for instance a jump

rail or a corresponding bracket provided on the surface of the feeding funnel. According to a preferred embodiment, the distance between the feeding funnel bottom part and the surface of the melt contained in the reactor is advantageously 0.8 – 1.3 meters, so that the anodes are dropped into the melt in an optimal fashion. According to a preferred embodiment, the anode bending element for bending the anode consists of four rolling rollers located above the feeding funnel. Advantageously the bending element provided in connection with the feeding funnel can be placed so that the anodes are bent immediately before dropping them into the smelting reactor. The diameter of the roller is 100 – 500 millimeters, advantageously 300 millimeters. The radius of curvature of an anode bent in the bending element is 1,000 – 3,000 millimeters, advantageously 1,500 millimeters. Now there is achieved a shape that is advantageous for the dropping of the anode, and the curved anode surface that meets the melt slows down the immersion of the anode, and hence the anode does not cause damage in the furnace bottom. According to a preferred embodiment of the invention, the anodes are arranged to drop into the smelting reactor one by one. According to another preferred embodiment, the anodes are arranged to drop into the reactor in batches of several anodes. According to a preferred embodiment, the anodes are dropped into the furnace so that the anode grip brackets, i.e. lugs, are pointed upwards. According to a preferred embodiment, in connection with the feeding funnel, there are provided at least two shutter elements in order to prevent the furnace atmosphere from leaking to the surroundings. According to a preferred embodiment, the feeding funnel includes elements that guide the sliding direction of the anode. Said guiding prevents a harmful rotating motion of the anode.

According to the method according to the invention for feeding an anode into a metallurgical smelting reactor, such as a flash converter, at least one anode is fed at a time through a feeding funnel made of at least one part to a smelting reactor, and said anode is also bent by means of a bending element, so that the anode is bent essentially completely and it meets the surface of the melt contained in the smelting reactor in an essentially horizontal position. According to a preferred embodiment of the method, the bending element is made of four rolling rollers with a diameter of 100 - 500 millimeters. According to a preferred embodiment, the

anode is in the bending element bent so that the obtained radius of curvature for the anode is essentially 1,000 – 3,000 millimeters. According to a preferred embodiment, anodes are dropped into the smelting reactor one by one. According to a preferred embodiment, anodes are dropped into the smelting reactor in batches of several anodes. According to a preferred embodiment of the method, an anode drops into the furnace so that the anode grip brackets, i.e. lugs, are pointed upwards. By using the arrangement and method according to the invention, anodes are fed into a smelting reactor in a simple and rapid fashion which does not disturb the converting process proper.

The invention is described in more detail below with reference to the appended drawings.

Figure 1 Arrangement according to the invention

Figure 1 illustrates an arrangement 1 and method according to the invention for feeding anode scrap into a metallurgical smelting reactor 2. The arrangement according to the invention is placed in the vicinity of the reaction shaft of a smelting reactor, such as a flash converter, above the furnace arc structure 3. In the vicinity of the reaction shaft, there prevails a high temperature, which enhances a rapid smelting of the anodes.

The undissolved anodes 4 left from the electrolysis are bent prior to feeding them into the smelting reactor 2. The anodes are either bent immediately after electrolysis in the electrolytic plant, or they are transported to be bent in connection with the smelting reactor. In an example according to figure 1, the bending element 5 for bending the anodes is placed in the immediate vicinity of a smelting reactor, such as a flash converter. Prior to dropping into the smelting reactor, the anodes are treated in a bending element 5. The bending element comprises a required number of rolling rollers 6, in the example depicted in the drawing four rollers, and the anodes are bent between said rollers. The anodes 4 are fed into the bending element for example along a separate feeding line, from which they are conducted to be bent either one by one or in batches of several anodes. The diameter of the rollers 6 is preferably 300 millimeters. The radius of

curvature of the anodes created in the bending can be adjusted, and advantageously it is 1,500 millimeters. The rolling rollers are operated for instance hydraulically, in which case a hydraulic pressure roller included in the roller is opened under strain. When the thickest part of the anode, i.e. the lugs thereof, falls in between the rollers, the roller is opened owing to the strain directed to it and releases the ready-bent anode from pressure. In other words, the rollers only bend the section of the anode proper. A straight anode is drawn between the rollers in an essentially vertical direction, so that its grip brackets, i.e. lugs 15 point upwards, and the anode is bent essentially completely. Thus the center of gravity of the anode is advantageously shifted, which further affects the dropping behavior of said anode. Anodes are bent either in batches or one by one.

According to the example, the anodes bent in the bending element are dropped into a feeding funnel 7, through which the anodes fall under gravity to the melt 8 contained in the smelting reactor 2. Advantageously the feeding funnel is in an inclined position, and it consists of two parts, the top part 9 and the bottom part 10. The feeding funnel 7 is constructed so that the bottom part 10 thereof forms a smaller angle with the horizontal line, whereas the top part 9 forms a larger angle. Owing to the different inclination of the bottom part, a vertical force is directed to the anode as it meets the bottom part of the funnel, which affects the trajectory of the anode. Preferably the angle between the top part and the bottom part is 20 degrees. The angle deviation of the bottom part of the feeding funnel causes a change in the anode momentum, which turns the anode into a horizontal position. The vertical force turns that end 11 of the anode that points downwardly towards the furnace upwardly, in the direction of the arrow. Thus the anode or anode batch is dropped on the surface of the melt 8, preferably in a horizontal position. The bottom linings of the furnace are saved from any damage caused by the collision of the falling anode, because the anode is not dropped vertically and directly onto the bottom.

The feeding funnel includes two shutter elements, such as shutters 12 and 14, in order to prevent the atmosphere prevailing in the furnace from leaking into the surroundings. In connection with the upper shutter 12, there is arranged a reception element 13 for receiving the anode, when the anode is dropped into the

feeding funnel 7. While the anode rests on the reception element, the upper shutter is opened, but the lower shutter 14 remains shut. When the anode has dropped past the upper shutter, the upper shutter is closed, whereafter the lower shutter 14 is opened, and the anode is free to fall past it. Now the anode falls onto the more inclined surface provided at the final end of the feeding funnel, where it is subjected to a vertical force, and its trajectory is altered. When necessary, the feeding funnel can be provided with elements guiding the sliding direction of the anode, said elements guiding the anodes downwardly in a desired fashion, in order to prevent the anode from rotating uncontrollably in the feeding funnel.

For a man skilled in the art, it is obvious that the various preferred embodiments of the invention are not restricted to the examples described above, but may vary within the scope of the appended claims.

CLAIMS

1. An arrangement for feeding an anode into a metallurgical smelting reactor (2), such as a flash converter, said arrangement including a feeding funnel (7) made of at least one part for feeding at least one anode (4) at a time into the smelting reactor, said arrangement also including a bending element (5) for bending the anode, **characterized** in that the essentially completely bent anode (4) is arranged to meet the surface of the melt (8) contained in the smelting reactor in an essentially horizontal position and the radius of curvature of an anode bent in the bending element (5) is essentially 1,000 – 3,000 millimeters.

2. An arrangement according to claim 1, **characterized** in that the feeding funnel (7) is arranged in the immediate vicinity of the reaction shaft of the smelting reactor (2).

3. An arrangement according to claim 1 or 2, **characterized** in that the feeding funnel (7) is made of two parts, a top part (9) and a bottom part (10), so that the angle of inclination of the top part with respect to the horizontal level is larger than that of the bottom part.

4. An arrangement according to claim 3, **characterized** in that the angle A between the top part (8) and the bottom part (10) of the feeding funnel (7) is essentially 10 – 30 degrees.

5. An arrangement according to claim 1 or 2, **characterized** in that the feeding funnel (7) is provided with a trajectory-shifting element in order to alter the trajectory of the anode.

6. An arrangement according to claim 3, 4 or 5, **characterized** in that the distance between the bottom part (10) of the feeding funnel (7) and the surface of the melt (8) contained in the reactor is advantageously 0.8 – 1.3 meters.

7. An arrangement according to claim 1, **characterized** in that the bending element (5) for bending the anode consists of four rolling rollers (6) that are located above the feeding funnel (7).

8. An arrangement according to claim 7, **characterized** in that the diameter of the rolling roller (6) is 100 – 500 millimeters.

9. An arrangement according to any of the preceding claims, **characterized** in that the anodes (4) are arranged to drop into the smelting reactor (2) one by one.

10. An arrangement according to claim 1, 2, 3, 4, 5, 6, 7, 8 or 9, **characterized** in that the anodes (4) are arranged to drop into the smelting reactor (2) in batches of several anodes.

11. An arrangement according to any of the preceding claims, **characterized** in that the anode (4) is arranged to drop into the smelting reactor (2) so that the anode grip brackets, i.e. lugs (15) are pointed upwards.

12. An arrangement according to any of the preceding claims, **characterized** in that in connection with the feeding funnel (7), there are provided at least two shutter elements (12, 14) for preventing the furnace atmosphere from leaking to the surroundings.

13. An arrangement according to any of the preceding claims, **characterized** in that the feeding funnel (7) is provided with elements for guiding the sliding direction of the anode (4).

14. A method for feeding an anode into a metallurgical smelting reactor (2), such as a flash converter, so that at least one anode (4) is fed at a time through a feeding funnel (7) made of at least one part into the smelting reactor, which anode is also bent by means of a bending element (5),

characterized in that the anode (4) is bent essentially completely, and that it meets the surface of the melt (8) contained in the smelting reactor at an essentially horizontal position and in the bending element (5), the anode is bent so that the obtained radius of curvature for the anode is essentially 1,000-3,000 millimeters.

15. A method according to claim 15, **characterized** in that the bending element (5) is made of four rolling rollers (6) with a diameter of 100 – 500 millimeters.

16. A method according to claim 15, 16 or 17, **characterized** in that the anodes (4) are dropped into the smelting reactor (2) one by one.

17. A method according to claim 15, 16 or 17, **characterized** in that the anodes (4) are dropped into the smelting reactor (2) in batches of several anodes.

18. A method according to claim 15, 16, 17, 18 or 19, **characterized** in that the anode (4) drops into the smelting reactor (2) so that the anode grip brackets, i.e. lugs (15) are pointed upwards.

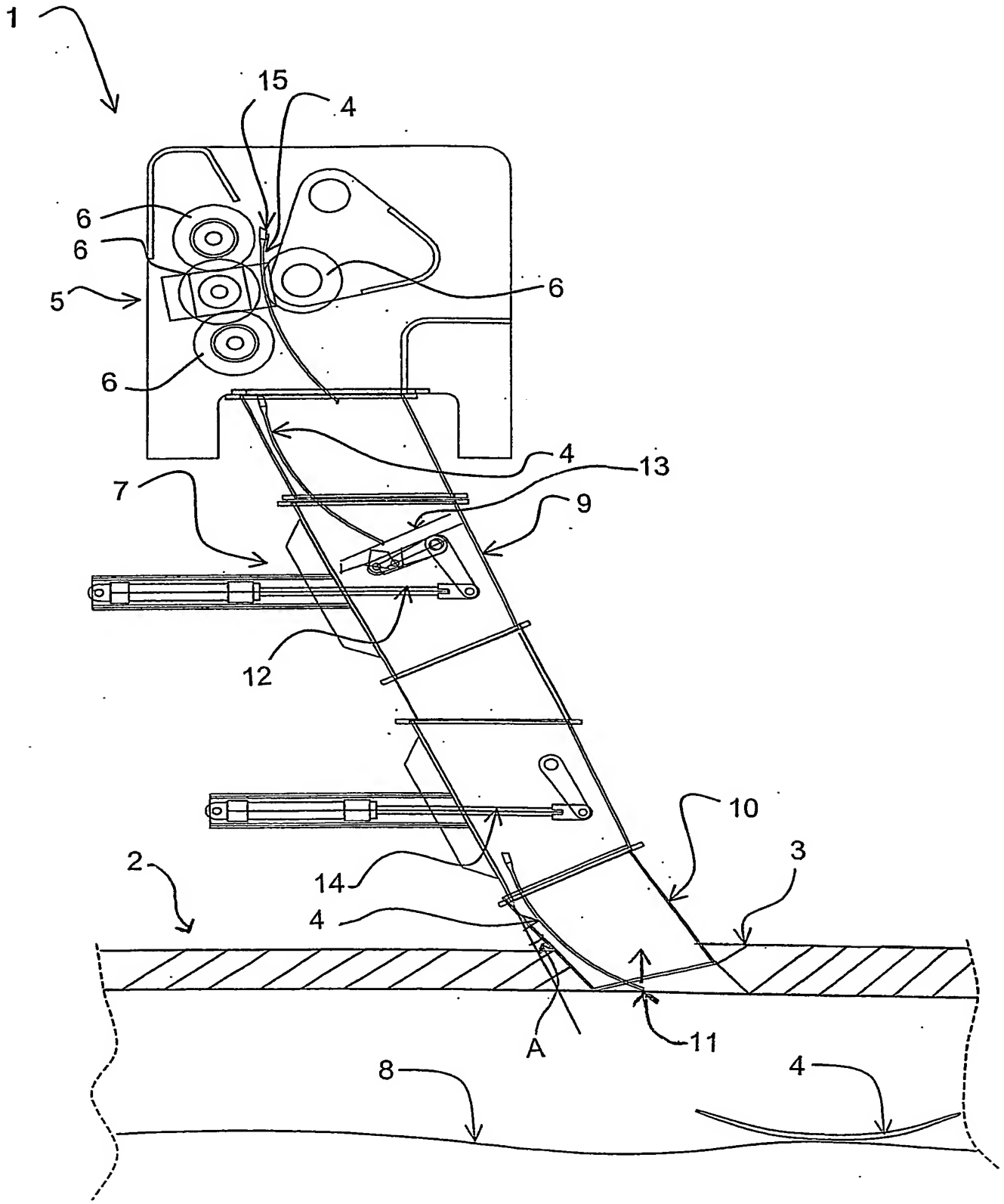

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00465

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F27D 3/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B66C, B21D, F27B, F27D, C22B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5685892 A (HIROAKI IKOMA ET AL), 11 November 1997 (11.11.97), column 5, line 24 - line 32; column 6, line 23 - line 26; column 8, line 6 - line 12, figures 1,7-9, claims 1,7,10	1-6,10-15, 18-20
P,X	US 6574263 B1 (OSAMU IIDA ET AL), 3 June 2003 (03.06.03), abstract	1-6,10-15, 18-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

26/07/03

International application No.
PCT/FI 03/00465

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5685892 A	11/11/97	AU 713992 B	16/12/99
		AU 7653296 A	11/12/97
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US 6574263 B1	03/06/03	NONE	